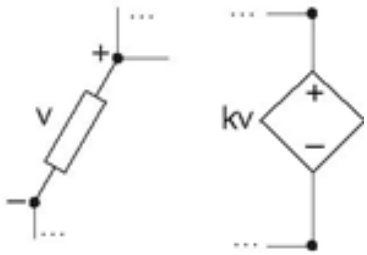

Figure 3.39 dependent sources Of the four possible dependent sources, depicted is a voltage-dependent voltage source in the context of a generic circuit.

Figure 3.40 shows the circuit symbol for the op-amp and its equivalent circuit in terms of a voltage-dependent voltage source.

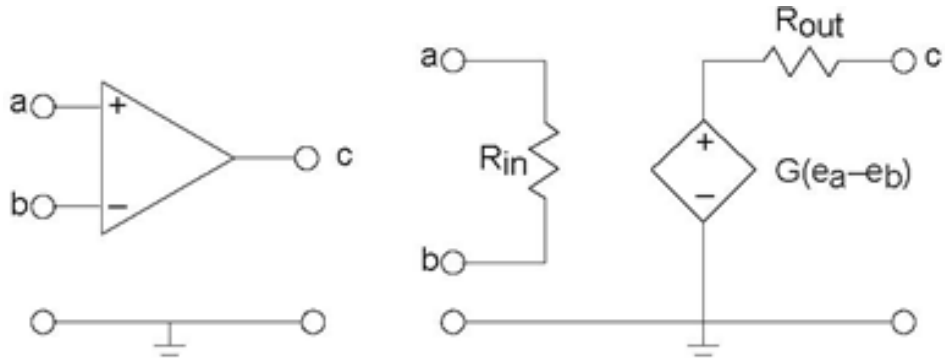

Figure 3.40 op-amp The op-amp has four terminals to which connections can be made. Inputs attach to nodes a and b, and the output is node c. As the circuit model on the right shows, the op-amp serves as an amplifier for the difference of the input node voltages.

Here, the output voltage equals an amplified version of the difference of node voltages appearing across its inputs. The dependent source model portrays how the op-amp works quite well. As in most active circuit schematics, the power supply is not shown, but must be present for the circuit model to be accurate. Most operational amplifiers require both positive and negative supply voltages for proper operation.

Because dependent sources cannot be described as impedances, and because the dependent variable cannot "disappear" when you apply parallel/series combining rules, circuit simplifications such as current and voltage divider should not be applied in most cases. Analysis of circuits containing dependent sources essentially requires use of formal methods, like the node method (Section 3.15). Using the node method for such circuits is not difficult, with node voltages defined across the source treated as if they were known (as with independent sources). Consider the circuit shown on the top in Figure 3.41.